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Sano, Hiroshi
Koizumi, Nozumu
Shinmyo, Atsuhiko

<120> Composite Utilization of a group of genes in biosynthetic Pathway of Caffeine

<130> KSM-0216

<160> 11

<170> PatentIn version 3.2

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<301> Ogawa et al.
<302> 7-Methylxanthine Methyltransferase of Coffee Plants, Gene Isolation and Enzymatic Properties
<303> Journal of Biological Chemistry
<304> 276
<305> 11
<306> 8213-8218
<307> 2001-03-16
<308> BAB39215
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Pro Asn Ile Asn Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser
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Gly Pro Asn Thr Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp
65 70 75 80

Lys Val Gly Gln Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln
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100 105 110

Leu Leu Pro Ser Phe Tyr Arg Lys Leu Glu Lys Glu Asn Gly Arg Lys
115 120 125

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Ser Thr Asn Lys Gly Ser Ile Tyr Ser Ser Lys Ala Ser Arg Leu Pro
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Val Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe
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Thr Cys Ile Cys Lys Gly Val Glu Leu Asp Ala Arg Asn Ala Ile Asp
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Tyr Glu Pro Ile Leu Ala Ser His Phe Gly Glu Ala Ile Ile Pro Asp
325 330 335

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Asn Ser Ala Tyr Asn Gln Leu Val Leu Ala Lys Val Lys Pro Val Leu
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Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser Gly Pro Asn Thr
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Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys Val Gly Gln
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gaa aag aag aat gaa tta gaa cgt ccc acc att cag att ttt ctg aat 344
Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile Phe Leu Asn
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Asp Leu Phe Pro Asn Asp Phe Asn Ser Val Phe Lys Leu Leu Pro Ser
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Gly Ser Ile Tyr Ser Ser Lys Ala Ser Arg Leu Pro Val Gln Lys Ala
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Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser Gly Pro Asn Thr		
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Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys Val Gly Gln		
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Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile Phe Leu Asn		
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gau cuu uuc cca aau gau uuc aau ucg guu uuc aag uug cug cca agc		392
Asp Leu Phe Pro Asn Asp Phe Asn Ser Val Phe Lys Leu Leu Pro Ser		
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Leu Ile Gly Ala Met Pro Gly Ser Phe Tyr Ser Arg Leu Phe Pro Glu		
135 140 145		
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Cys Ile Val Glu Glu Glu Gly Ser Phe Glu Ile Leu Tyr Leu Glu Thr		
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Phe Lys Val Leu Tyr Asp Ala Gly Phe Ser Ile Asp Asp Glu His Ile		
295 300 305		
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Val Gly Gln Glu Glu Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile
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Phe Leu Asn Asp Leu Phe Gln Asn Asp Phe Asn Ser Val Phe Lys Leu
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115 120 125

Gly Ser Cys Leu Ile Ser Ala Met Pro Gly Ser Phe Tyr Gly Arg Leu
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Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu
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Arg Ile His Ser Lys Glu Leu Phe Ser Arg Gly Arg Met Leu Leu Thr
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Cys Ile Cys Lys Val Asp Glu Tyr Asp Glu Pro Asn Pro Leu Asp Leu
 225 230 235 240

Leu Asp Met Ala Ile Asn Asp Leu Ile Val Glu Gly His Leu Glu Glu
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Glu Lys Leu Ala Ser Phe Asn Leu Pro Phe Phe Thr Pro Ser Ala Glu
 260 265 270

Glu Val Lys Cys Ile Val Glu Glu Glu Gly Ser Phe Glu Ile Leu Tyr
 275 280 285

Leu Glu Thr Phe Lys Ala His Tyr Asp Ala Gly Phe Ser Ile Asp Asp
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Asp Tyr Pro Val Arg Ser His Phe Gln Val Tyr Gly Asp Glu His Ile
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Lys Ala Glu Tyr Val Ala Ser Leu Ile Arg Ser Val Tyr Glu Pro Ile
 325 330 335

Leu Ala Ser His Phe Gly Glu Ala Ile Met Pro Asp Leu Phe His Arg
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aac atc aac aag tgc att aaa gtt gc gat ttg gga tgc gct tct gga Asn Ile Asn Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser Gly	50	55	60	192
cca aac aca ctt tta aca gtg cg gac att gtg caa agt att gac aaa Pro Asn Thr Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys	65	70	75	240
gtt ggc cag gaa gag aag aat gaa tta gaa cgt ccc acc att cag att Val Gly Gln Glu Glu Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile	85	90	95	288
ttt ctg aat gat ctt ttc caa aat gat ttc aat tcg gtt ttc aag ttg Phe Leu Asn Asp Leu Phe Gln Asn Asp Phe Asn Ser Val Phe Lys Leu	100	105	110	336
ctg cca agc ttc tac cgc aaa ctc gag aaa gaa aat gga cgc aag ata Leu Pro Ser Phe Tyr Arg Lys Leu Glu Lys Glu Asn Gly Arg Lys Ile	115	120	125	384
gga tcg tgc cta ata agc gca atg cct ggc tct ttc tac ggc aga ctc Gly Ser Cys Leu Ile Ser Ala Met Pro Gly Ser Phe Tyr Gly Arg Leu	130	135	140	432
tcc ccc gag gag tcc atg cat ttt ttg cac tct tgt tac agt gtt cat Phe Pro Glu Glu Ser Met His Phe Leu His Ser Cys Tyr Ser Val His	145	150	155	480
tgg tta tct cag gtt ccc agc ggt ttg gtg att gaa ttg ggg att ggt Trp Leu Ser Gln Val Pro Ser Gly Leu Val Ile Glu Leu Gly Ile Gly	165	170	175	528
gca aac aaa ggg agt att tac tct tcc aaa gca agt cgt ccg ccc gtc Ala Asn Lys Gly Ser Ile Tyr Ser Ser Lys Ala Ser Arg Pro Pro Val	180	185	190	576
cag aag gca tat ttg gat caa ttt acg aaa gat ttt acc aca ttt cta Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu	195	200	205	624
agg att cat tcg aaa gag ttg ttt tca cgt ggc cga atg ctc ctt act Arg Ile His Ser Lys Glu Leu Phe Ser Arg Gly Arg Met Leu Leu Thr	210	215	220	672
tgc att tgt aaa gta gat gaa tac gac gaa ccg aat ccc cta gac tta Cys Ile Cys Lys Val Asp Glu Tyr Asp Glu Pro Asn Pro Leu Asp Leu	225	230	235	720
ctt gac atg gca ata aac gac ttg att gtt gag gga cat ctg gag gaa Leu Asp Met Ala Ile Asn Asp Leu Ile Val Glu Gly His Leu Glu Glu	245	250	255	768
gaa aaa ttg gct agt ttc aat ctt cca ttc ttt aca cct tca gca gaa Glu Lys Leu Ala Ser Phe Asn Leu Pro Phe Phe Thr Pro Ser Ala Glu	260	265	270	816
gaa gta aag tgc ata gtt gag gag gaa ggt tct ttt gaa att tta tac Glu Val Lys Cys Ile Val Glu Glu Gly Ser Phe Glu Ile Leu Tyr	275	280	285	864

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290 295 300	
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Asp Tyr Pro Val Arg Ser His Phe Gln Val Tyr Gly Asp Glu His Ile	
305 310 315 320	
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Lys Ala Glu Tyr Val Ala Ser Leu Ile Arg Ser Val Tyr Glu Pro Ile	
325 330 335	
ctc gca agt cat ttt gga gaa gct att atg cct gac tta ttc cac agg	1056
Leu Ala Ser His Phe Gly Glu Ala Ile Met Pro Asp Leu Phe His Arg	
340 345 350	
ctt gcg aag cat gca gca aag gtt ctc cac ttg ggc aaa ggc tgc tat	1104
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Pro Phe Leu Glu Gln Cys Ile Arg Glu Leu Leu Arg Ala Asn Leu Pro	
35 40 45	
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Pro Asn Thr Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys	
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cag aag gca uau uug gau caa uuu acg aaa gau uuu acc aca uuu cua Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu 195 200 205			624
agg auu cau ucg aaa gag uug uuu uca cgu ggc cga aug cuc cuu acu Arg Ile His Ser Lys Glu Leu Phe Ser Arg Gly Arg Met Leu Leu Thr 210 215 220			672
ugc auu ugu aaa gua gau gaa uac gac gaa ccg aau ccc cua gac uua Cys Ile Cys Lys Val Asp Glu Tyr Asp Glu Pro Asn Pro Leu Asp Leu 225 230 235 240			720
cuu gac aug gca aua aac gac uug auu guu gag gga cau cug gag gaa Leu Asp Met Ala Ile Asn Asp Leu Ile Val Glu Gly His Leu Glu Glu 245 250 255			768
gaa aaa uug gcu agu uuc aau cuu cca uuc uuu aca ccu uca gca gaa Glu Lys Leu Ala Ser Phe Asn Leu Pro Phe Thr Pro Ser Ala Glu 260 265 270			816
gaa gua aag ugc aua guu gag gag gaa ggu ucu uuu gaa auu uua uac Glu Val Lys Cys Ile Val Glu Glu Gly Ser Phe Glu Ile Leu Tyr 275 280 285			864
cug gag acu uuu aag gcc cau uau gau gcu ggc uuc ucu auu gau gau Leu Glu Thr Phe Lys Ala His Tyr Asp Ala Gly Phe Ser Ile Asp Asp 290 295 300			912
gau uac cca gua aga ucc cau uuc caa gua uac ggc gau gaa cau auu Asp Tyr Pro Val Arg Ser His Phe Gln Val Tyr Gly Asp Glu His Ile 305 310 315 320			960
aaa gca gag uau gug gca uca uua auu aga uca guu uac gaa ccc auc Lys Ala Glu Tyr Val Ala Ser Leu Ile Arg Ser Val Tyr Glu Pro Ile 325 330 335			1008
cuc gca agu cau uuu gga gaa gcu auu aug ccu gac uua uuc cac agg Leu Ala Ser His Phe Gly Glu Ala Ile Met Pro Asp Leu Phe His Arg 340 345 350			1056
cuu gcg aag cau gca gca aag guu cuc cac uug ggc aaa ggc ugc uau Leu Ala Lys His Ala Ala Lys Val Leu His Leu Gly Lys Gly Cys Tyr 355 360 365			1104
aau aau cuu auc auu ucu cuc gcc aaa aag cca gag aag uca gac gug Asn Asn Leu Ile Ile Ser Leu Ala Lys Lys Pro Glu Lys Ser Asp Val 370 375 380			1152
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35 40 45

Asn Ile Asn Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser Gly
50 55 60

Pro Asn Thr Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys
65 70 75 80

Val Gly Gln Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile
85 90 95

Phe Leu Asn Asp Leu Phe Gln Asn Asp Phe Asn Ser Val Phe Lys Ser
100 105 110

Leu Pro Ser Phe Tyr Arg Lys Leu Glu Lys Glu Asn Gly Arg Lys Ile
115 120 125

Gly Ser Cys Leu Ile Gly Ala Met Pro Gly Ser Phe Tyr Gly Arg Leu
130 135 140

Phe Pro Glu Glu Ser Met His Phe Leu His Ser Cys Tyr Cys Leu His
145 150 155 160

Trp Leu Ser Gln Val Pro Ser Gly Leu Val Thr Glu Leu Gly Ile Ser
165 170 175

Ala Asn Lys Gly Cys Ile Tyr Ser Ser Lys Ala Ser Arg Pro Pro Ile
180 185 190

Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu
195 200 205

Arg Ile His Ser Glu Glu Leu Ile Ser Arg Gly Arg Met Leu Leu Thr
210 215 220

Trp Ile Cys Lys Glu Asp Glu Phe Glu Asn Pro Asn Ser Ile Asp Leu
225 230 235 240

Leu Glu Met Ser Ile Asn Asp Leu Val Ile Glu Gly His Leu Glu Glu
245 250 255

Glu Lys Leu Asp Ser Phe Asn Val Pro Ile Tyr Ala Pro Ser Thr Glu
260 265 270

Glu Val Lys Cys Ile Val Glu Glu Gly Ser Phe Glu Ile Leu Tyr
275 280 285

Leu Glu Thr Phe Lys Val Pro Tyr Asp Ala Gly Phe Ser Ile Asp Asp
290 295 300

Asp Tyr Gln Gly Arg Ser His Ser Pro Val Ser Cys Asp Glu His Ala
305 310 315 320

Arg Ala Ala His Val Ala Ser Val Val Arg Ser Ile Phe Glu Pro Ile
325 330 335

Val Ala Ser His Phe Gly Glu Ala Ile Met Pro Asp Leu Ser His Arg
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Ile Ala Lys Asn Ala Ala Lys Val Leu Arg Ser Gly Lys Gly Phe Tyr
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agc tac gcc aag aac tca ttc tac aat ctg ttt ctc atc agg gtg aaa 96
Ser Tyr Ala Lys Asn Ser Phe Tyr Asn Leu Phe Leu Ile Arg Val Lys
20 25 30

cct atc ctt gaa caa tgc ata caa gaa ttg ttg cggt gcc aac ttg ccc 144
Pro Ile Leu Glu Gln Cys Ile Gln Glu Leu Leu Arg Ala Asn Leu Pro
35 40 45

aac atc aac aag tgc att aaa gtt gcg gat ttg gga tgc gct tct gga 192
Asn Ile Asn Lys Cys Ile Lys Val Ala Asp Leu Gly Cys Ala Ser Gly
50 55 60

cca aac aca ctt tta aca gtt cggt gac att gta caa agt att gac aaa 240
Pro Asn Thr Leu Leu Thr Val Arg Asp Ile Val Gln Ser Ile Asp Lys
65 70 75 80

gtt ggc cag gaa aag aag aat gaa tta gaa cgt ccc acc att cag att 288
Val Gly Gln Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile
85 90 95

ttt ctg aat gat ctt ttc caa aat gat ttc aat tcg gtt ttc aag tcg Phe Leu Asn Asp Leu Phe Gln Asn Asp Phe Asn Ser Val Phe Lys Ser	336
100 105 110	
ctg cca agc ttc tac cgc aaa ctt gag aaa gaa aat gga cgc aaa ata Leu Pro Ser Phe Tyr Arg Lys Leu Glu Lys Glu Asn Gly Arg Lys Ile	384
115 120 125	
gga tca tgc ctg ata ggc gca atg cct ggc tct ttc tac ggc aga ctc Gly Ser Cys Leu Ile Gly Ala Met Pro Gly Ser Phe Tyr Gly Arg Leu	432
130 135 140	
tcc ccc gag gag tcc atg cat ttt tta cac tct tgt tac tgt ttg cat Phe Pro Glu Glu Ser Met His Phe Leu His Ser Cys Tyr Cys Leu His	480
145 150 155 160	
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165 170 175	
gcg aac aaa ggg tgc att tac tct tcc aaa gca agt cgt ccg ccc atc Ala Asn Lys Gly Cys Ile Tyr Ser Ser Lys Ala Ser Arg Pro Pro Ile	576
180 185 190	
cag aag gca tat ttg gat caa ttt acg aaa gat ttt acc aca ttt ctt Gln Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu	624
195 200 205	
agg att cat tcg gaa gag ttg att tca cgt ggc cga atg ctc ctt act Arg Ile His Ser Glu Glu Leu Ile Ser Arg Gly Arg Met Leu Leu Thr	672
210 215 220	
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225 230 235 240	
ctt gag atg tca ata aac gac ttg gtt att gag gga cat ctg gag gaa Leu Glu Met Ser Ile Asn Asp Leu Val Ile Glu Gly His Leu Glu Glu	768
245 250 255	
gaa aaa ttg gac agt ttc aat gtt cca atc tat gca cct tca aca gaa Glu Lys Leu Asp Ser Phe Asn Val Pro Ile Tyr Ala Pro Ser Thr Glu	816
260 265 270	
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275 280 285	
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290 295 300	
gat tac caa gga aga tcc cat tcc cca gta tcc tgc gat gaa cat gct Asp Tyr Gln Gly Arg Ser His Ser Pro Val Ser Cys Asp Glu His Ala	960
305 310 315 320	
aga gca gcg cat gtg gca tct gtc gtt aga tca att ttc gaa ccc atc Arg Ala Ala His Val Ala Ser Val Val Arg Ser Ile Phe Glu Pro Ile	1008
325 330 335	
gtc gca agt cat ttt gga gaa gct atc atg cct gac tta tcc cac agg Val Ala Ser His Phe Gly Glu Ala Ile Met Pro Asp Leu Ser His Arg	1056
340 345 350	
att gcg aag aat gca gca aag gtt ctt cgc tcc ggc aaa ggc ttc tat Ile Ala Lys Asn Ala Ala Lys Val Leu Arg Ser Gly Lys Gly Phe Tyr	1104
355 360 365	
gat agt ctt atc att tct ctc gcc aaa aag cca gag aag tca gac gtg 13	1152

Asp Ser Leu Ile Ile Ser Leu Ala Lys Lys Pro Glu Lys Ser Asp Val
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96
Ser Tyr Ala Lys Asn Ser Phe Tyr Asn Leu Phe Leu Ile Arg Val Lys
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 Pro Ile Leu Glu Gln Cys Ile Gln Glu Leu Leu Arg Ala Asn Leu Pro
 35 40 45

aac	auc	aac	aag	ugc	auu	aaa	guu	gcg	gau	uug	gga	ugc	gcu	ucu	gga		192
Asn	Ile	Asn	Lys	Cys	Ile	Lys	Val	Ala	Asp	Leu	Gly	Cys	Ala	Ser	Gly		
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cca	aac	aca	cuu	uuu	aca	guu	cg	gac	auu	gua	caa	agu	auu	gac	aaa	
Pro	Asn	Thr	Leu	Leu	Thr	Val	Arg	Asp	Ile	Val	Gln	Ser	Ile	Asp	Lys	240
65					70				75					80		

guu ggc cag gaa aag aag aau gaa uua gaa cgu ccc acc auu cag auu
 Val Gly Gln Glu Lys Lys Asn Glu Leu Glu Arg Pro Thr Ile Gln Ile
 85 90 95

uuu cug aau gau cuu uuc caa aau gau uuc aau ucg guu uuc aag ucg
 Phe Leu Asn Asp Leu Phe Gln Asn Asp Phe Asn Ser Val Phe Lys Ser
 100 105 110 336

cug cca agc uuc uac cg ^c aaa cuu gag aaa gaa aau gga cg ^c aaa aua	384
Leu Pro Ser Phe Tyr Arg Lys Leu Glu Lys Glu Asn Gly Arg Lys Ile	
115 120 125	

gga uca ugc cug aua ggc gca aug ccu ggc ucu uuc uac ggc aga cuc 432
 Gly Ser Cys Leu Ile Gly Ala Met Pro Gly Ser Phe Tyr Gly Arg Leu
 130 135 140

uuc	ccc	gag	gag	ucc	aug	cau	uuu	uuu	cac	ucu	ugu	uac	ugu	uug	cau	480
Phe	Pro	Glu	Glu	Ser	Met	His	Phe	Leu	His	Ser	Cys	Tyr	Cys	Leu	His	
145		150							155					160		

ugg uua ucu cag guu ccc agc ggu uug gug acu gaa uug ggg auc agu
 Trp Leu Ser Gln Val Pro Ser Gly Leu Val Thr Glu Leu Gly Ile Ser
 165 170 175

gcg aac aaa ggg ugc auu uac ucu ucc aaa gca agu cgu ccg ccc auc
 Ala Asn Lys Gly Cys Ile Tyr Ser Ser Lys Ala Ser Arg Pro Pro Ile
 180 185 190

cag aag gca uau uug gau caa uuu acg aaa gau uuu acc aca uuu cuu
 Gin Lys Ala Tyr Leu Asp Gln Phe Thr Lys Asp Phe Thr Thr Phe Leu
 195 200 205 624

agg	auu	cau	ucg	gaa	gag	uug	auu	uca	cgu	ggc	cga	aug	cuc	cuu	acu		672
Arg	Ile	His	Ser	Glu	Glu	Leu	Ile	Ser	Arg	Gly	Arg	Met	Leu	Leu	Thr		
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Trp	Ile	Cys	Lys	Glu	Asp	Glu	Phe	Glu	Asn	Pro	Asn	Ser	Ile	Asp	Leu		
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cuu	gag	aug	uca	aua	aac	gac	uug	guu	auu	gag	gga	cau	cug	gag	gaa		768
Leu	Glu	Met	Ser	Ile	Asn	Asp	Leu	Val	Ile	Glu	Gly	His	Leu	Glu	Glu		
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Glu	Lys	Leu	Asp	Ser	Phe	Asn	Val	Pro	Ile	Tyr	Ala	Pro	Ser	Thr	Glu		
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gaa	gua	aag	ugc	aua	guu	gag	gag	gaa	ggu	ucu	uuu	gaa	auu	uuu	uac		864
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Leu	Glu	Thr	Phe	Lys	Val	Pro	Tyr	Asp	Ala	Gly	Phe	Ser	Ile	Asp	Asp		
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gau	uac	caa	gga	aga	ucc	cau	ucc	cca	gua	ucc	ugc	gau	gaa	cau	gcu		960
Asp	Tyr	Gln	Gly	Arg	Ser	His	Ser	Pro	Val	Ser	Cys	Asp	Glu	His	Ala		
						305			310				315			320	
aga	gca	gcf	cau	gug	gca	ucu	guc	guu	aga	uca	auu	uuc	gaa	ccc	auc		1008
Arg	Ala	Ala	His	Val	Ala	Ser	Val	Val	Arg	Ser	Ile	Phe	Glu	Pro	Ile		
						325			330				335				
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Val	Ala	Ser	His	Phe	Gly	Glu	Ala	Ile	Met	Pro	Asp	Leu	Ser	His	Arg		
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auu	gcg	aag	aau	gca	gca	aag	guu	cuu	cgc	ucc	ggc	aaa	ggc	uuc	uaa		1104
Ile	Ala	Lys	Asn	Ala	Ala	Lys	Val	Leu	Arg	Ser	Gly	Lys	Gly	Phe	Tyr		
						355			360				365				
gau	agu	cuu	auc	auu	ucu	cuc	gcc	aaa	aag	cca	gag	aag	uca	gac	gug		1152
Asp	Ser	Leu	Ile	Ile	Ser	Leu	Ala	Lys	Lys	Pro	Glu	Lys	Ser	Asp	Val		
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23